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Analysis of some measurement parameters that may predict the risk of developing obesity: a clinical study

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ABSTRACT

Aim: Obesity is a severe and chronic disease, which is currently increasing rapidly. The aim of this study was to reveal some parameters that can predict the risk of obesity and to create a new scale using these parameters.

Material and Method: The demographic information of the study subjects was recorded, together with the anthropometric measurements of Body Mass Index (BMI), blood pressure, height, body weight, waist circumference, and hip circumference were recorded.

Results: Evaluation was made of 74 subjects, comprising 11 (14.9%) females and 63 (85.1%) males with a median age of 34 years (24-45). Mean body weight was measured as 77.3±12.46 kg, height as 174.3±8.86 cm, waist circumference as 84 (66-103) cm, hip circumference as 97 (83-121) cm, and BMI as 25.4±3.21 kg/m². It was seen that the risk of developing obesity could increase when age and duration of work increased, with an increased frequency of eating outside the home, in the absence of regular exercise, and when the waist and hip circumference values increased. Regression analysis showed that body weight, waist, and hip circumference measurement values could be used to predict the obesity development risk. Finally, a valid and reliable scale called OBEZRISK was created that would easily predict the risk of obesity development in individuals.

Conclusion: The study results showed that body weight, waist, and hip circumference measurement values could be used to predict the risk of obesity development in individuals. It was also concluded that the OBEZRISK scale could be used to predict the risk of developing obesity.

Keywords: BMI, hip circumference, waist circumference, obesity, risk of developing obesity

INTRODUCTION

Obesity is a multifactorial chronic disease, which diminishes quality of life, causes a shortening of life, and is currently tending to increase gradually throughout the world (1). According to World Health Organisation (WHO) data (2), obesity affects over 300 million people and approxmately one billion people are classified as overweight. In addition to environmental factors such as a sedentary lifestyle and changes in eating habits, some inherited features also play an important role in the increase in obesity prevalence (3). At least 2.8 million people die annually due to being overweight and obese, and the risk of diseases such as heart disease, stroke, diabetes, and cancer increases gradually due to the increase in body mass index (BMI). Therefore, raising awareness about obesity, shifting daily eating habits in a healthy direction, increasing physical activity, and acquiring healthy living habits are important in obesity prevention and obesity treatment (4).

Although BMI values can show whether people are obese, they cannot predict the risk of an individual classified as overweight becoming obese. Therefore, there is a need for a new scale that can predict the risk of obesity developing in people who are in the overweight category and which will enable precautions to be taken for these people. The aim of this study was to draw attention to the need to predict the risk of obesity development and to provide a solution for this need by creating a new scale that can predict this risk.

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MATERIAL AND METHOD

The study was carried out with the permission of Batman Regional State Hospital Non-Invasive Clinical Researches Ethics Committee (Date: 12.12.2014 and Decision No: 56). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Participants

The study participants were selected from volunteers, who were informed about the aims of the study and all those included in the study signed the Informed Consent Form. A questionnaire was then completed for each participant to collect the study data of age, gender, marital status, working time, comorbid diseases (smoking and alcohol use and dosage, diabetes mellitus, chronic lung disease, chronic liver disease, etc.), and lifestyle (frequency and type of exercise, nutrition habits). Blood pressure, body height, body weight, waist circumference, hip circumference, and BMI measurements were also recorded.

Methods

The BMI value of the patients was calculated using the "body weight (kg)/height (m^2)" formula and classified using the WHO BMI classification (5). Patients with BMI ≥30 kg/m^2 were classified as obese, 25.0 <BMI <29.9 kg/m^2 as overweight, 18.5 <BMI <24.9 kg/m^2 as normal, and BMI <18.5 kg/m^2 as thin.

Measurements were taken of each patient wearing light clothing using the same instruments and on an empty stomach, and an empty bladder. Body weight measurement was made with a standard scale device, and height measurements were made with bare feet, the backs of the participants turned and perpendicular to the measuring instrument, and the gluteus and back area tangent to the wall.

Waist circumference was measured at the level of the navel, using a fixed tension-supported tape measure, with the participant standing upright and without contracting the abdominal muscles. For the diagnosis of abdominal obesity, a waist circumference measurement >88 cm in females and >102 cm in males was taken as the baseline value (3,6). Hip circumference was measured from the most prominent point of the gluteus maximus muscle and the line passing over the pubis using a fixed tension-supported tape measure. After sitting and resting for approximately 15 minutes, systolic and diastolic blood pressure values were measured in both arms with a standard blood pressure monitor.

Statistical Analysis

The data obtained from the study were analyzed using SPSS vn. 20.0 software (Statistical Package for the Social Sciences Inc, IBM). The normal distribution of the study data was evaluated using the Kolmogorov-Smirnov test, and parametric data were presented as mean±standard deviation (SD) values, non-parametric data as median (minimum-maximum) values, and categorical data as number (n) and percentage (%). Parametric data were compared using the Independent Samples t-test, non-parametric data using the Mann Whitney U test, and categorical data using Pearson's Chi-square test. A value of $p<0.05$ was considered statistically significant.

Spearman's rho Correlation test was used to test the relationships between study data. ROC-Curve analysis was applied to determine parameters that could predict the risk of obesity, and Logistic Regression analysis was used to determine the best parameter to predict the risk of obesity. The Odds Ratio test was applied to the study data to show the factors that increase the obesity risk.

In addition, to create a scale (OBEZRISK) to predict obesity risk and to evaluate the validity and reliability of this scale, Factor analysis (ie Principal Component Analysis), and a Reliability test were applied.

RESULTS

Evaluation was made of a total of 74 participants, comprising 11 (14.9%) females and 63 (85.1%) males, with a maximum age of 45 years, 39 (52.7%) aged < 35 years, and 35 (47.3%) >35 years. Of the participants, 29 (39.2%) were single, 44 (59.5%) were married, and 1 (1.4%) was widowed. Duration of employment was reported as <10 years by 48 (64.9%) participants and > 10 years by 26 (35.1%). A chronic disease was determined in 6 (8.3%) participants. Alcohol consumption was reported by 13 (17.5%) participants, and 38 (51.4%) were smokers with average smoking of 1 pack-day. Regular exercise was taken by 14 (18.9%) participants (3 female, 11 male) with walking being the most common form at 23%, followed by football at 13.5%, and indoor sports at 2.7%. In response to the lifestyle questions, 34 (46%) participants stated that they always used elevators when available, 34 (45.9%) that they used them sometimes, and 6 (8.1%) that they did not use elevators. When means of transport were questioned, 61 (82.4%) participants drove to the workplace and 9 (12.2%) walked. In respect of general eating habits, 55 (74.4%) participants ate home-cooked

meals and 12 (17.6%) ate restaurant meals. Breakfast was reported not to be eaten by 25 (33.8%), and always eaten by 10 (13.5%) (**Table 1**).

The mean anthropometric measurements of the participants were determined as height 174.1±8.86 cm, body weight 77.3±12.46 kg, waist circumference 84 (66-103) cm, hip circumference 97 (83-121) cm, and BMI 25.4±3.21 kg/m² (**Table 2**). It was seen that 5 (6.8%) participants (1 female and 4 male) had a BMI value of ≥30 kg/m² in the obesity category, and 34 (45.9%) males had a BMI value between 25-29.9 kg/m² in the overweight category. The participants were asked whether they had had their blood pressure measured before, and 44.6% of the participants stated that they had had their blood pressure measured before. The measurements taken in this study showed that the systolic blood pressure of none of the participants exceeded the limit of 140 mm Hg, while the diastolic blood pressure of 5 participants (6.8%) was 90 mmHg (**Table 2**).

In the comparisons of the findings of the male and female groups, it was found that most females were aged <35 years (Z=-2.713, p=0.007). When the duration of employment was compared according to gender, males had a longer duration of employment (Z=-2.051, p=0.044). In the comparisons of smoking status according to gender, no significant difference was found between the groups (X2=2.999, p=0.083). The male participants were deterrmined to have higher values of height (t=-5.529, p<0.001), body weight (t=6.253, p<0.001), waist circumference (t=-2.963, p=0.004), and BMI (t=3.242, p=0.002) than those of females. No difference was determined between male and female participants in terms of exercising, using elevators, using vehicles, nutrition, and breakfast habits (**Table 3**, **Figure 1**).

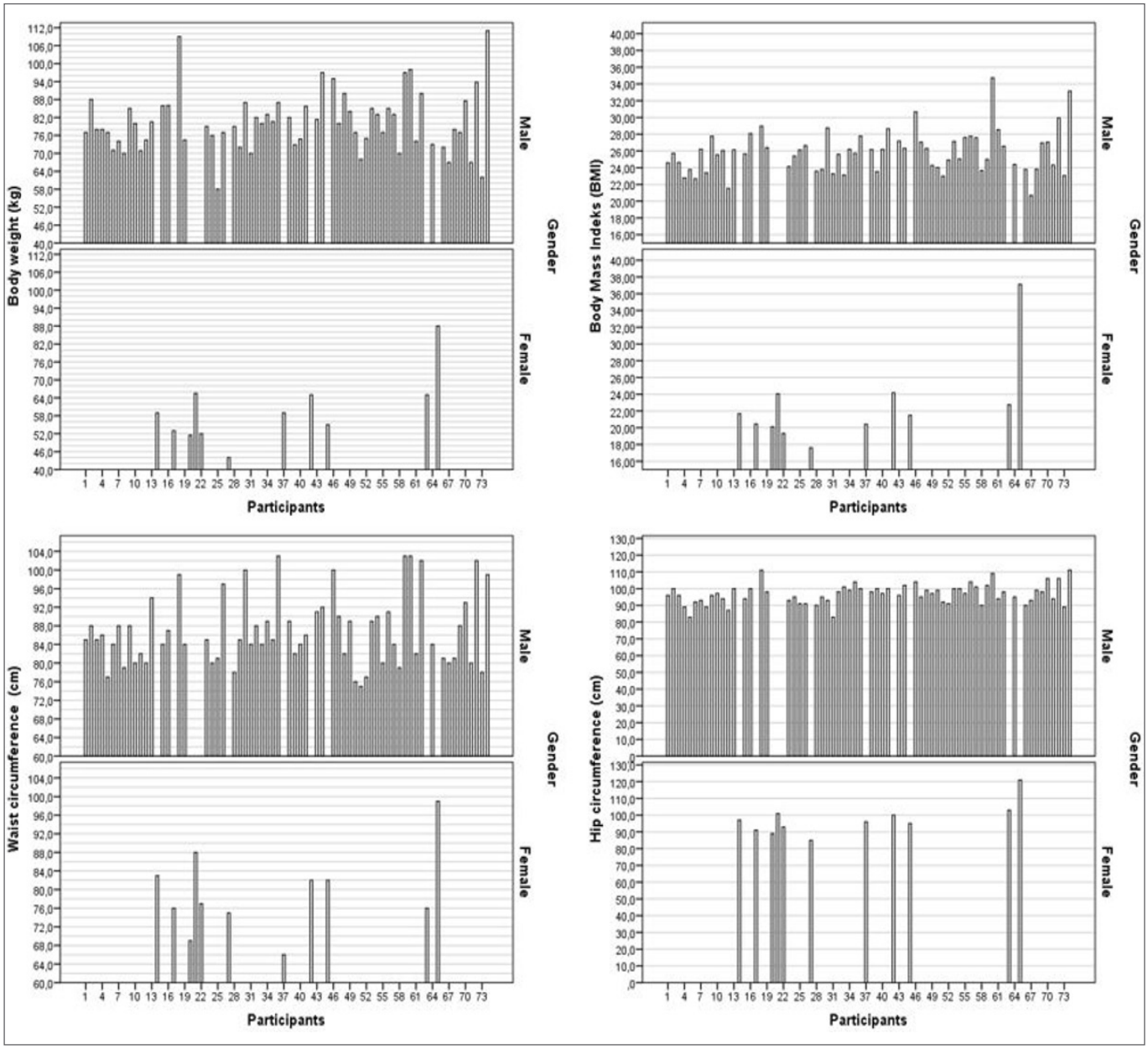

Figure 1. The distribution of gender in different groups

Table 1. The characteristics of the study sample

Variable	N (%)
Age (year)	34 (24-45)
Age group	
<35-year-old	39 (%52.7)
≥35-year-old	35 (%47.3)
Gender	
Female	11 (%14.9)
Male	63 (%85.1)
Marital status	
Single	29 (%39.2)
Married	44 (%59.5)
Widow	1 (%1.4)
Working time in the profession	
<10 years	48 (%64.9)
≥10 years	26 (%35.1)
Comorbidity	
No	68 (%91.9)
Diabetes mellitus	1 (%1.4)
Chronic lung disease	3 (%4.1)
Chronic liver disease	1 (%1.4)
Osteogenesis imperfecta	1 (%1.4)
Smoking	
No	36 (%48.6)
Yes	38 (%51.4)
Alcohol consumption	
No	61 (81.5)
Yes	13 (%17.5)
Habit of exercising	
No	60 (%81.1)
Yes	14 (%18.9)
Elevator use	
No	6 (%8.1)
Yes	34 (%45.9)
Always	34 (%46.0)
Type of transportation	
Walk	9 (%12.2)
Vehicle	61 (%82.4)
Mixed	4 (%5.4)
Breakfast habit	
No	25 (%33.8)
Sometimes	18 (% 24.3)
Often	21 (%28.4)
Always	10 (%13.5)
Eating place habit	
House	55 (%74.4)
Restaurant	12 (%17.6)
Mixed	6 (%8.1)

Table 2. The mean anthropometric measurements of the study

Variable	N (%)
Body height (cm)	174.2±8.86
Body weight (kg)	77.3±12.46
Waist circumference (cm)	84 (66-103)
Hip circumference (cm)	97 (83-121)
Body Mass Index (kg/m²)	25.4±3.21
Systolic blood pressure (mmHg)	110 (80-130)
Diastolic blood pressure (mmHg)	70 (50-90)

Table 3. The distribution (in %) for gender according to the demographic characteristics (i.e., body mass index, habit of exercising and age).

Variable	Female	Male	t / Z/ X²	p
	Mean±SD/ Median (min-max)/ N (%)	Mean±SD/ Median (min-max)/ N (%)		
Age (year)	29 (23-38)	35 (21-45)	-2.713†	0.007
Body height (cm)	162.73±4.71	176.23±7.83	-5.529*	<0.001
Body weight (kg)	59.73±11.54	80.37±9.85	-6.253*	<0.001
Waist circumference (cm)	79.36±9.06	86.84±7.49	-2.963*	0.004
Hip circumference (cm)	96 (85-121)	97 (83-111)	-0.110†	0.913
Body Mass Index	22.65±5.18	25.85±2.51	-3.242*	0.002
Marital status			1.378‡	0.502
Single	6 (20.7%)	23 (79.3%)		
Married	5 (11.4%)	39 (88.6%)		
Widow	0 (0.0%)	1 (100.0%)		
Working time (year)	4.95±3.05	8.05±4.82	-2.051*	0.044
Comorbidity			0.017‡	0.897
No	10 (14.7%)	58 (85.3%)		
Yes	1 (16.7%)	5 (83.3%)		
SBH (mmHg)	100 (80-130)	120 (90-130)	-3.060†	0.002
DBH (mmHg)	60 (50-90)	70 (60-90)	-2.224†	0.026
Smoking			2.999‡	0.083
No	8 (22.2%)	28 (77.8%)		
Yes	3 (7.9%)	35 (92.1%)		
Smoking (pack/ day)	0 (0-1)	0.5 (0-2)	-2.156†	0.031
Alcohol consumption			3.015‡	0.221
No	11 (18.1%)	50 (81.9%)		
Yes	0 (0.0%)	13 (100.0%)		
Habit of exercising			0.588‡	0.443
No	8 (13.3%)	52 (86.7%)		
Yes	3 (21.4%)	11 (78.6%)		
Exercise duration (hours/week)	0 (0-5)	0 (0-10)	-0.682	0.495
Elevator use			1.432‡	0.698
No	0 (0.0%)	6 (100.0%)		
Yes	6 (17.6%)	28 (82.4%)		
Always	5 (14.7%)	29 (85.3%)		
Type of transportation			7.108‡	0.069
Walk	2 (22.2%)	7 (77.8%)		
Vehicle	9 (14.8%)	52 (85.2%)		
Mixed	0 (0.0%)	4 (100.0%)		
Breakfast habit			5.489‡	0.139
No	7 (28.0%)	18 (72.0%)		
Sometimes	2 (11.1%)	16 (88.9%)		
Often	1 (4.8%)	20 (95.2%)		
Always	1 (10.0%)	9 (90.0%)		
Eating place habit			2.371‡	0.668
House	10 (18.2%)	45 (81.8%)		
Restaurant	1 (7.7%)	12 (92.3%)		
Mixed	0 (0.0%)	6 (100.0%)		

(*) t value, Independent Samples t test; (†) Z value, Mann Whitney U test, (‡) X2 value, Pearson's chi-square test, p<0.05

The correlation analysis revealed a positive correlation between BMI and age (r=0.454, p<0.001), gender (r=0.421, p=0.001), marital status (r=0.274, p=0.018), time in occupation (r=0.334, p=0.004), eating habits (r=0.294, p=0.011), waist circumference (r=0.732, p<0.001) and hip circumference (r=0.583, p<0.001) values, and a negative correlation was found between BMI values and exercise habits (r=0.262, p=0.024). The ROC-Curve analysis showed that if body weight was >87 kg, this parameter could be 100% sensitive and 92% specific in predicting the risk of obesity (AUC=0.972, p<0.001). When waist circumference was measured >98 cm, this parameter was found to be 100% sensitive and 95% specific in predicting the risk of obesity (AUC=0.979, p<0.001). When hip circumference was measured >104 cm, it was found that this parameter could be 100% sensitive and 94% specific in predicting the risk of obesity (AUC=0.982, p<0.001). The Logistic Regression analysis determined that the hip circumference measurement value could be used as the best parameter to predict the risk of developing obesity (B=0.503, Wald=7.639, p=0.006) (**Table 4**, **Figure 2**). However, the Odds Ratio analysis showed that no parameter alone would be sufficient to increase the risk of obesity.

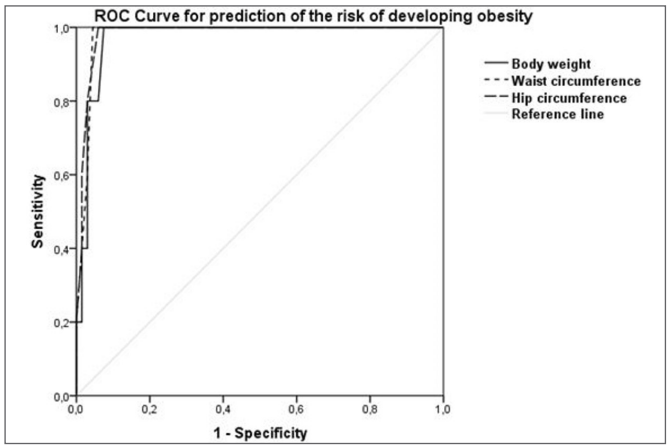

Figure 2. ROC Curve for prediction of the risk of developing obesity

The factor analysis results confirmed that the sample size of this study was sufficient to develop a scale that can measure the risk of developing obesity (Kaiser-Meyer-Olkin Measure of Sampling Adequacy test value = 0.626). Test results based on the correlation matrix table suggested that only "body weight", "waist circumference", "hip circumference", "exercise habit", and "duration of exercise" could be components of the OBEZRISK scale (Bartlett's Test of Sphericity value=199.795, p <0.001). The results of the analysis also showed that the OBEZRISK scale scores were equally distributed under two different factors (explained variance was 83.88%). The variance explained by the Factor 1 (i.e. anthropometric risk) scores was higher than the variance explained by the Factor 2 (i.e. habits risk) scores (31.68% versus 52.20%, respectively). The 2-factor variation in factor analysis showed that this scale could predict both the risk of anthropometric measurements and the risk of exercise habits (Eigenvalues=2.61 and 1.58). The reliability analysis test showed that this scale had moderate reliability as the Cronbach's alpha value was between 0.60 and 0.80 (Cronbach's alpha=0.642, intraclass correlation=0.642, 95% CI=0.499-0.755). The F test revealed no similarity between the parameters constituting this scale (F=2.791, p<0.001) (**Table 5**, **Table 6**).

Table 6. The cut off prediction results among anthropometric measurements and habit risk

Prediction	Variable	Cut-off value	Score	Person's score
Anthropometric risk				
	Body height	>87 kg	1	
	Waist circumference	>98 cm	1	
	Hip circumference	>104 cm	1	
Habit risk				
	Do you exercise regularly?	No	1	
	How many hours a week do you exercise?	No	1	
Total Score				

Table 4. ROC-Curve and Logistic Regression analysis for risk of developing obesity

ROC-Curve analysis for risk of developing obesity

Variable	AUC	Cut-off value	p	Sensitivity	Specificity	95 CI	
						Lower	Upper
Body height	0.972	>87 kg	<0.001	%100	%92	0.934	1,000
Waist circumference	0.979	>98 cm	<0.001	%100	%95	0.948	1.000
Hip circumference	0.982	>104 cm	<0.001	%100	%94	0.954	1.000
OBESRISK	0.993	Score >3	<0.001	%100	%94	0.975	1.000

Logistic Regression analysis for risk of developing obesity

			Obesity risk		
		Observed	Predicted		Percentage
			No	Yes	
Hip circumference	Obesity risk	No	68	1	98.6%
		Yes	2	3	60.0%
		Overall percentage			95.9%
			B	Wald	p
Hip circumference			0.503	7.639	0.006

Table 5. Analysis results of Factor Test and Reliability Test

	Factor test	
	Factor 1 (Anthropometric risk)	**Factor 2 (Habit risk)**
"Body weight"	0.907	
"Waist circumference"	0.879	
"Hip circumference"	0.842	
"Do you exercise regularly?"		0.953
"How many hours a week do you exercise?"		0.955
Eigenvalues	2.61	1.58
% of Variance	52.20	52.20
Cumulative %	31.68	83.88
Kaiser-Meyer-Olkin measure of sampling adequacy		0.626
Bartlett's test of Sphericity		199.795 (df=10, p<0.001)

Reliability test						
Variable	**Cronbach's Alpha**	**Intraclass Correlation**	**95% CI**		**F Test**	
			Lower	**Upper**	**F**	**p**
OBEZRİSK scale	0.656	0.656	0.515	0.766	2.911	<0.001

DISCUSSION

Obesity and obesity-related problems are currently considered one of the most important public health problems today. Obesity is known to be the main risk factor for Type 2 Diabetes, and an increase of one kilogram in body weight increases the risk of diabetes by 5%. This relationship leads to the risk of developing metabolic syndrome (7, 8, 9, 10, 11). Although metabolic syndrome is mostly known as a problem in adults, it has emerged as an important social problem in childhood, especially in adolescence. It has been stated that this situation is closely related to nutrition, exercise habits, and advancing age (12, 13, 14). There has also been shown to be a higher risk of early mortality for individuals with a sedentary lifestyle compared to those who are more active. A study in Turkey reported that 40% of the study participants stated that exercise was important, but a very low rate of those performed sports effectively. Studies in the literature have shown that obesity rates can vary according to the mobility of society and eating habits (15). As obesity is increasing in Turkey and throughout the world, it is now accepted as necessary to follow national and international policies for the prevention of this disease. The need to increase societal awareness about obesity has begun to be accepted with the identification of gaps in the existing knowledge gaps, and educational tools to fill these gaps have been created (5, 16).

The majority of the current study participants were male, married, and had been employed for less than 10 years. Type II diabetes mellitus type II was present in 1 participant, chronic lung disease in 3, chronic liver disease in 1, chronic bone disease in 1, and the rest were healthy. It was observed that most of the participants did not exercise regularly, used the elevator instead of climbing the stairs, used a motor vehicle instead of walking, did not eat breakfast regularly, but most preferred home-cooked meals for other meals. The number of smokers and non-smokers was similar and the smokers consumed approximately 1 pack of cigarettes per day. Most of the participants did not consume alcohol. In the light of these findings, it was observed that although most of the study participants did not have any comorbid disease, a high percentage preferred a sedentary lifestyle without exercise and smoked.

Waist circumference measurements vary in different populations, so it has been suggested that waist circumference should be determined for each society and the criteria should be adjusted accordingly to determine the real risk (17). There is no acceptable study on this subject in Turkey as yet. In the current study, the prevalence of abdominal obesity was 45.5% in females and 15.9% in males. Although there was a difference between these rates, there was no statistically significant difference between the genders in terms of detecting abdominal obesity, which was thought to be due to the low number of female participants in the study. The mean BMI value of the whole study group was 25.4±3.21 kg/m², which was between the upper limit of normal and the overweight limit. However, when the data were examined in detail, it was seen that the BMI value of 5 participants was >29.9, placing them in the obesity category, and almost half of the participants were in the overweight category and all of these subjects were male. When the relationship between obesity and the study parameters was examined, it was seen that the risk of developing obesity could increase with increased age, waist and hip circumference values, duration of working, frequency of eating outside the home, and in the absence of regular exercise. Thus, excess body weight could be associated with more ready-to-eat food consumption and insufficient physical activity due to working conditions.

When the study participants were evaluated according to male and female gender, it was observed that males were older, had worked for longer, and had higher height, body weight, BMI, waist circumference, systolic and diastolic blood pressure measurement values, and smoked more than females. However, no differences were observed between the genders in terms of hip circumference measurement values, alcohol consumption, marital status, comorbid diseases, exercise habits, elevator and vehicle usage habits, and general eating and breakfast habits.

As a result of the ROC-Curve analysis applied to predict the risk of obesity, it was determined that body weight, and waist and hip circumference values could predict the risk of developing obesity. It was concluded that no other study parameters could be a predictive marker. The results of the logistic regression analysis applied to find out which of the parameters obtained in the ROC analysis could be the best predictor for obesity risk, showed that the hip circumference measurement value could be the best parameter to be used for the prediction of the risk of obesity. However, from the Odds ratio analysis applied to test the parameters that may increase the obesity risk, it was concluded that none of the demographic and measurement-based parameters used in the study directly increased the risk of developing obesity.

Finally, at the end of this study, it was seen that a new and simple scale was needed to easily predict the risk of developing obesity. Therefore, to meet this need, a new scale named "OBEZRISK" was developed using the parameters of this study. It was thought that the "body weight (kg)", "waist circumference (cm)", "hip circumference (cm)" "exercise habit", and "exercise duration" parameters in this scale could predict the risk of developing obesity. The results of the Factor analysis and Reliability test showed that the OBEZRISK scale created in this study can be accepted as a valid and reliable scale.

The ROC-Curve analysis showed that a scale score >3 points indicated a higher risk of developing obesity (**Table 4**). According to these findings, the scoring of this scale and the interpretation of the scores can be as follows: the risk of developing obesity may increase when body weight, waist, and hip circumference measurement values are all measured high on this scale. If more than four parameters are scored on this scale, it can be concluded that the risk of developing obesity may be almost certain. Therefore, at the end of the study, it was thought that this newly produced scale could be used as a valid and reliable scale to safely and easily predict the risk of developing obesity in individuals. Nevertheless, further studies with larger samples and a greater variety of parameters are required to re-test and confirm the reliability and validity of the scale.

Limitations

This study had some limitations. First, this study was retrospective and had a small number of participants. Therefore, the power to reflect the results obtained from this study to the general population was low. Second, metabolic syndrome markers were not included in this study, as blood biochemistry analysis data and radiological imaging (such as abdominal ultrasonography) were not available. Finally, during the creation of the OBEZRISK scale obtained from this study, the participants included in the study were cross-sectional (people with a university education level) and remained far from reflecting the general population. However, the factor analysis test results revealed that the number of participants was sufficient to create the scale. Therefore, the results obtained from the study and the scale created can be accepted as enlightening for future studies. However, it was also accepted that this scale should be retested for reliability and validity by conducting studies with larger samples and a greater variety of evaluation parameters.

CONCLUSION

In conclusion, the results of this study demonstrated that although most participants did not have a comorbid disease, a high percentage had a sedentary and non-exercise lifestyle and smoked. In addition, it was seen that the risk of developing obesity could increase when age increased, the duration of working increased, the habit of eating outside the home increased, the values of waist and hip circumferences increased, and there was a pattern of not exercising. Finally, it can be suggested that the newly created scale called OBEZRISK could be used as a valid and reliable scale to safely and easily predict the risk of developing obesity.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Batman Regional State Hospital Non-Invasive Clinical Researches Ethics Committee (Date: 12.12.2014, Decision No: 56)

Informed Consent: All patients signed the free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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